

of reference of the temperatures is unusual. The temperature for any day is not referred to the ascertained 25-year mean for that day, but to the corresponding point of the first component in the harmonic resolution of the 25-year curve, and it is the differences from this standard which are considered. To obtain trustworthy means for the several winds the differences for each ten days of the year or for each month are grouped, and the winds are also grouped according to their average annual effect upon temperature, which is tabulated in the paper. Thus N., N.E., and E. winds (E., S.E. and S. gradients) are grouped as "cold winds," S., S.W. and W. winds as "warm," and N.W. and S.E. as "temperate."

A series of diagrams exhibits the results obtained, and it is noteworthy that the chief characteristics of the peculiarity which it is sought to explain, viz. maxima of warming effect in January and July with maxima of cooling effect in May and November, are traceable in different ways in the temperature curves for separate winds and still more markedly in those for the groups of winds. Thus the peculiarity is only partly attributable to the prevalence of warm or cold winds; part is due to a similar peculiarity in the seasonal variation of temperature of the individual winds themselves. Thus the May minimum is shown to be due partly to the special prevalence of "cold winds" and partly to the relative coldness of those winds at that season: the corresponding November minimum is attributed to the prevalence of "temperate winds" and the exceptional coldness of those winds at that period of the year. The July maximum corresponds to the exceptional warmth of the usually cold or temperate groups of winds and the January maximum corresponds especially to the frequency of occurrence of "warm winds."

The half-yearly component of the variation of temperature in individual winds remains unexplained, but the following facts are noted in connection with it: first, a similar effect is found in the temperature variation of sea-water at stations surrounding these islands and, secondly, a similar second order component with similar epoch is found in the seasonal variation of the barometric gradient between London and Valencia and still more conspicuously in the barometric gradient between London and Aberdeen.

The data as to the relation between wind, or gradient, and temperature have been obtained for Kew only.

The paper also contains an account of the variation of temperature with the type of weather prevailing, whether cyclonic or anticyclonic, and it is shown that the effect in question cannot be ascribed to the differences of frequency of these types at different seasons.

To the paper is appended a note on the effect of sea temperature upon the seasonal variation of air temperature. In this an attempt is made, by the application of the principle of the vector composition of sine curves of the same period but with different epochs, to resolve a resultant annual temperature oscillation into components corresponding to the "original oscillation" and the superposed effect of sea or land. By the application of the principle in the case of Kew, it is shown that the amplitude of the "original oscillation" at Kew cannot be less than  $5.3^{\circ}\text{F}$ . and the effect of the surrounding sea corresponds to an oscillation which cannot exceed  $8.3^{\circ}\text{F}$ . in amplitude. The resultant oscillation at Kew ought, however, to be resolved into three components—the original component, that due to the surrounding land and that due to the sea; but there are not sufficient data to determine them directly.

Application is also made of the same principles to the resolution of the temperature variation at Scilly and at a station in Siberia. The numerical results are not to be regarded as final on account of the inadequacy of the data used.

#### RESEARCH IN UNIVERSITY EDUCATION.

THE development of higher education in the direction of research was the keynote of the address delivered by Prof. J. G. Macgregor, F.R.S., at the University of Edinburgh on October 15, in opening the Natural Philosophy Class as the late Prof. Tait's successor. Research methods should be used in education from the Kindergarten to the University; because the spirit of self-help, of inquiry and of inventiveness which they encourage is at the foundation of all progress in science and industry. When science began to be studied in our schools and colleges about forty years ago, the schoolmen of the day followed,

with few exceptions, the methods which they used in teaching the humanities. Lectures and books provided the material and examinations the test of retentivity. The system was fundamentally wrong when applied to science though sound for studies of literature. Investigation is necessary in both cases if progress is to be made, but, as Prof. Macgregor remarks, "while in science the outfit of the laboratory consists of apparatus and tools, in language it consists of the text and the lexicon."

The neglect of the spirit of research in the study of science is largely responsible for the want of public sympathy with work of investigation and the inadequacy of provision made for it. Nations like those of America and Germany which have recognised that research is not only an educational discipline but exercises a powerful influence upon industrial development, now take the initiative where we were once the leaders. Formerly, it was necessary for the young American to go to Germany to obtain the pioneer spirit, but the need no longer exists, for the leading universities of the United States have been remodelled on modern lines. In Great Britain the conservative spirit prevails and has prevented the course of university development demanded by the requirements of the age. The characteristic attitudes of the German, American and British peoples are as old as the prophets, from whom Prof. Macgregor derives an appropriate illustration.

"The German," he remarks, "may be said to have sought wisdom for her own sake as being more precious than rubies, and he is finding now that she has length of days in her right hand, and in her left riches and honour. The American, though he sought her not, heard her crying at the gates: I, Wisdom, dwell with prudence and find out knowledge of witty inventions; and having heeded her cry, he too is reaping his reward. We Britons have neither sought her for her own sake nor heeded her cry, but have said to ourselves: There is no new thing under the sun. He that increaseth knowledge increaseth sorrow, and much study is a weariness to the flesh. The sleep of the labouring man is sweet. Yet a little more sleep, a little more slumber, a little more folding of the hands in sleep. And now we fear that poverty is coming as one that travelleth, and want as an armed man."

It is the duty of those of us who are awake to national necessities to exert ourselves in the endeavour to arouse the British people to action, and our political leaders to a sense of responsibility for future welfare. More liberal provision must be made for the increase of knowledge, and men who devote themselves to research must be prized as highly as those who have contributed in other ways to the progress of the nation. There must be increase of funds and increase of freedom in the universities and the guiding principle of the work must be research. Prof. Macgregor emphasises these points in the following concluding part of his address.

Research is costly. It means increased teaching staff and adequate provision of all the requisite appliances. Much good work, it is true, may be done with a comparatively small outfit; but to obtain the best result, the outfit, if not lavish, must at any rate be generous. And as the importance of research by students has never been recognised amongst us, the present outfit is meagre.

It will perhaps occur to most of you that the princely gift of 2,000,000*l.* which Mr. Carnegie has made to the Scottish people for reducing the cost of the higher education and increasing its efficiency may be drawn upon for the present purpose, and may be sufficient. Doubtless it will be drawn upon, but it will certainly not be sufficient. When we think of the number of colleges which are to be assisted, and of the number of different departments in each, we see at once that the amount which any one department may expect to receive must be comparatively small. The moiety of the Carnegie fund which is devoted to equipment would build, equip and maintain perhaps about twenty laboratories of the more expensive kind such as are required in the various sciences and in their numerous applications. It becomes obvious, therefore, both how munificent a gift the Scottish people have received, and, since each university ought to possess many of these laboratories, how inadequate it is for the introduction of research study into the various departments of university work.

In Germany the nation itself provides for research, and does so generously, because it is, and has long been, an investigating nation. We are not; and if we introduce research into our universities it will be because, like the Americans, we have

come to recognise its educational and industrial importance. It will be individuals who will lead in this recognition; and we must therefore rely, as the Americans have done, mainly on the public spirit of citizens. The reports of the United States Commissioner of Education show that there has been in recent years a steady increase, year by year, both in the benefactions and in the Government grants which the universities and colleges have received, culminating in 1898-9 (the date of the latest report) in benefactions amounting to 4,400,000*l.* for that one year, and Government grants amounting to 1,500,000*l.*—facts which fully explain how it is that the great universities, which, of course, have been receiving the lion's share, have been able to build up, in a comparatively short time, well-equipped research schools in many departments of study. If we are to do the same, we must not rest satisfied with the equipment which the Carnegie fund can provide, but must supplement it with a liberality which, if not individually so princely as Mr. Carnegie's, will collectively exceed it in amount.

And here let me suggest that the endowment of research in Natural Philosophy in this university might well form the first instance of such enlightened liberality. Tait needs no effort of ours for the perpetuation of his name. By his scientific work he has raised for himself, as a distinguished leader in the advancement of knowledge, a more lasting monument than any that we could erect. But of his services to the University and the State there is no memorial. There are thousands of his students who have drunk from the well of his inspiration and been made stronger men by the draught. There are tens of thousands of his fellow-citizens whose pride in the Scottish metropolis has received new justification from his whole-souled devotion to its maintenance as a centre of light and leading. Is it too much to expect that they should found a research laboratory bearing his name, and thus appropriately mark their appreciation of a great Scotsman who showed by the exercise of his own creative power that Britain at least shares in the intellectual leadership of the world, and by the cultivation of creative power in his students did what he could to maintain her industrial leadership as well?

There would be little advantage in the possession of research funds, however, without full freedom to use them; and at present they could be used only to a limited extent. Research work is recognised in our universities as qualifying for certain high degrees, so high that no one is supposed to be fitted for them until five years have elapsed from the date of his having become a Master of Arts or a Bachelor of Science, so high consequently that they are taken only by the few. It is not recognised as qualifying for the M.A. and B.Sc. degrees themselves, and any time which may be spent by an undergraduate in investigation is thus condemned by our regulations to be, so far as the degree is concerned, "time elaborately thrown away." Nor is it easy to gain full freedom to teach by research; for when we ask how the recognition of research study in the undergraduate courses is to be obtained, we find that changes in regulations can be made only with the concurrence of the Scottish Universities Committee of the Privy Council, and that it is hopeless to expect the concurrence of this Committee unless it is asked for by at least two universities. It will at once be obvious that the advocate of reform has an arduous task. For he must persuade in succession his own university, a second university, and the Privy Council Committee. And this procedure is requisite, not merely to secure the desired recognition of research study, but to carry out any large measure of reform. It has obviously been devised with the object of preventing hasty and ill-considered change on the part of any of our universities, and any change whatever which does not commend itself to more than one. It may be admitted at once that it is admirably suited to the purpose; for if we think of the correspondence involved in the advocacy of any reform, the iteration and reiteration of argumentation, the button-holing, perhaps even the lobbying and "log-rolling," it becomes apparent that no better system could be devised to dampen the enthusiasm of the reformer and to perpetuate things as they are.

It is perhaps improper in one who has only recently joined your staff of teachers, and may not be fully acquainted with the advantages of the organisation referred to, to express any decided opinion about it. But, as an old student, who for years has been watching the course of his Alma Mater from afar, and is thus in a position to let you see yourselves as others see you, I may allow myself to say that the Ordinances of the Scottish Universities Commission and the authority of the Privy Council Committee seem to me to be millstones about the necks

of the Scottish universities, which, unless the universities have a supernatural buoyancy, must sink them lower and lower relatively to the progressive universities of the world.

The most important condition of the steady progress of the German university has been the *Lehrfreiheit*, and the corollary insisted upon by the universities and recognised by the State, that when the best available teachers have been selected they must be supposed to know better than any external committee what is to be taught and how the teaching is to be done, and that consequently they must be free to regulate and modify their teaching as knowledge advances and as methods are improved.

And, similarly, one essential condition of the progress of the American university has been its autonomy. Johns Hopkins University, non-existent twenty-five years ago, is to-day one of the leading universities of the world, because it put at its head a talented educational reformer and gave him a free hand; and in consequence of a similar policy, Harvard, in the last quarter of a century, has been transformed from being a leading American university to being a leading world's university. These two great institutions work on quite different lines. Had either required to persuade the other of the value of its organisation and then to persuade a Committee of Congress, it is safe to assert that the extraordinary development which both have exhibited would never have occurred.

The question of the relation of the universities to the Privy Council Committee, of the advantages of individual as opposed to collective development, of the kinds of change which ought to be capable of being made from within, and the kinds which ought to be submitted to an external tribunal—these are questions of too great complexity to be discussed in the last paragraphs of an address. But when the introduction of research work into the undergraduate courses is found to be among the reforms which must wait for collective action and the consent of an external body, it becomes obvious, I think, that the line between changes which may be made from within and changes which require approval from without has been so drawn as to hamper unduly the development of our universities, and that it requires to be redrawn in the spirit of progress.

Meantime, as to the particular change which I am advocating to-day, we need not despair. Reform in this direction is in the air. Under the stress of the national industrial crisis and the growing conviction that something must be wrong in our educational system, those educationists who have long advocated it are securing to-day an attention such as they have never before received. And when we find the Chancellor of the University of Birmingham, a leading Cabinet Minister, eager to introduce research into his university, and the chairman of the Educational Section of the British Association, our Minister of Education, as eager to introduce it into his schools, we are encouraged to hope that at no distant date the movement may be fully developed which was inaugurated in this university through the profound educational insight of Prof. Tait, and that all our universities may be enabled to exert the stimulating influence that schools of the higher education should do, not merely on industrial development, but on all forms of progressive activity.

### UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—The Financial Board has published a proposal that the University should purchase some six acres of land belonging to Downing College, and adjoining the new buildings for geology and botany. The site is practically the only one now available for the extension of the museums, and it will, if not secured by the University, be divided up by new streets for ordinary building purposes. The price is about 25,000*l.*, which, in the absence of benefactions, will have to be raised by loan.

Dr. Anningson, Dr. Collingridge, Prof. Woodhead, Mr. J. E. Purvis and Dr. Tatham have been appointed University examiners in sanitary science.

At a meeting held under the auspices of the Philosophical Society on November 18, it was decided to invite the British Association to visit Cambridge in 1904 or 1905.

MR. CARNEGIE has announced that he will give 400,000*l.* more to Pittsburgh, half to the Carnegie Institute and half to the new technical school, the building of which will shortly be commenced.